DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 24

SYLLABUS : Thermodynamics-1 (Thermal equilibrium, zeroth law of thermodynamics, concept of temperature, Heat, work and internal energy, Different thermodynamic processes)

Max. Marks : 116 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 29 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 For an isothermal expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is

(a) $-\gamma^{1/2}\frac{\Delta V}{V}$ (b) $-\frac{\Delta V}{V}$ (c) $-\gamma\frac{\Delta V}{V}$ (d) $-\gamma^{2}\frac{\Delta V}{V}$

Q.2 When an ideal gas in a cylinder was compressed isothermally by a piston, the work done on the gas was found to be 1.5×10^4 Joule. During this process about

(a) 3.6×10^3 cal of heat flowed out from the gas

(b) 3.6×10^3 cal of heat flowed into the gas

(c) 1.5×10^4 cal of heat flowed into the gas

(d) 1.5×10^4 cal of heat flowed out from the gas

Q.3 The latent heat of vaporisation of water is 2240 J/gm. If the work done in the process of expansion of 1 g of water is 168 J, then increase in internal energy is

(a) 2408 J (b) 2240 J

(c) 2072 J (d) 1904 J

Q.4 One mole of an ideal gas expands at a constant temperature of 300 K from an initial volume of 10 litres to a final volume of 20 litres. The work done in expanding the gas is

$(R = 8.31 \text{ J/mole} - \text{K})$

(a) 750 Joules (b) 1728 Joules

(c) 1500 Joules (d) 3456 Joules

RESPONSE GRID				
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Q.5 The pressure in the tyre of a car is four times the atmospheric pressure at 300 K. If this tyre suddenly bursts, its new temperature will be $(\gamma = 1.4)$

(a) $300(4)^{1.4/0.4}$ (b) $300\left(\frac{1}{4}\right)^{-0.4/1.4}$

(c) $300(2)^{-0.4/1.4}$ (d) $300(4)^{-0.4/1.4}$

Q.6 A monoatomic gas $(\gamma = 5/3)$ is suddenly compressed to $\frac{1}{8}$ of its original volume adiabatically, then the pressure of the gas will change to

(a) $\frac{24}{5}$ (b) 8

(c) $\frac{40}{3}$ (d) 32 times its initial pressure

Q.7 An ideal gas at $27°C$ is compressed adiabatically to $\frac{8}{27}$ of its original volume. If $\gamma = \frac{5}{3}$, then the rise in temperature is

(a) 450 K (b) 375 k (c) 225 K (d) 405 K

Q.8 A given system undergoes a change in which the work done by the system equals the decrease in its internal energy. The system must have undergone an

(a) Isothermal change (b) Adiabatic change

(c) Isobaric change (d) Isochoric change

Q.9 Helium at 27° has a volume of 8 litres. It is suddenly compressed to a volume of 1 litre. The temperature of the gas will be $[\gamma = 5/3]$

(a) 108°C (b) 9327°C (c) 1200°C (d) 927°C

Q.10 One mole of an ideal gas at an initial temperature of TK does 6 R joules of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is 5/3, the final temperature of gas will be

(a) $(T + 2.4)K$ (b) $(T - 2.4)K$

(c) $(T + 4)K$ (d) $(T - 4)K$

Q.11 For an adiabatic expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to

(a) $-\sqrt{\gamma \frac{\Delta V}{V}}$ (b) $-\frac{\Delta V}{V}$

(c) $-\gamma \frac{\Delta V}{V}$ (d) $-\gamma^2 \frac{\Delta V}{V}$

Q.12 If 300 ml of gas at 27°C is cooled to 7°C at constant pressure, then its final volume will be

(a) 540 ml (b) 350 ml

(c) 280 ml (d) 135 ml

Q.13 A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest when the expansion is

(a) isothermal (b) isobaric

(c) adiabatic (d) equal in all cases

Q.14 How much work to be done in decreasing the volume of and ideal gas by an amount of $2.4 \times 10^{-4}\,m^3$ at normal temperature and constant normal pressure of $1 \times 10^5\,N/m^2$

(a) 28 Joule (b) 27 Joule

(c) 25 Joule (d) 24 Joule

Q.15 One mole of a perfect gas in a cylinder fitted with a piston has a pressure P, volume V and temperature T. If the temperature is increased by 1 K keeping pressure constant, the increase in volume is

(a) $\frac{2V}{273}$ (b) $\frac{V}{91}$ (c) $\frac{V}{273}$ (d) V

Q.16 Work done by 0.1 mole of a gas at $27°C$ to double its volume at constant pressure is $(R = 2\ \text{cal mol}^{-1\circ}K^{-1})$

(a) 54 cal (b) 600 cal (c) 60 cal (d) 546 cal

Q.17 When an ideal diatomic gas is heated at constant pressure, the fraction of the heat energy supplied which increases the internal energy of the gas, is

(a) $\frac{2}{5}$ (b) $\frac{3}{5}$ (c) $\frac{3}{7}$ (d) $\frac{5}{7}$

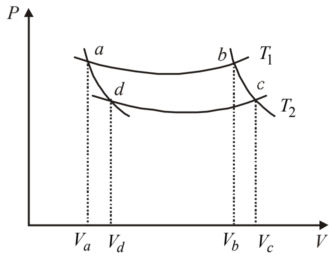
RESPONSE GRID					
	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ
	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ		

Q.18 When heat is given to a gas in an isothermal change, the result will be
(a) external work done
(b) rise in temperature
(c) increase in internal energy
(d) external work done and also rise in temp.

Q.19 An ideal gas expands isothermally from a volume V_1 to V_2 and then compressed to original volume V_1 adiabatically. Initial pressure is P_1 and final pressure is P_3. The total work done is W. Then
(a) $P_3 > P_1, W > 0$
(b) $P_3 < P_1, W < 0$
(c) $P_3 > P_1, W < 0$
(d) $P_3 = P_1, W = 0$

Q.20 An ideal gas expands in such a manner that its pressure and volume can be related by equation PV^2 = constant. During this process, the gas is
(a) heated
(b) cooled
(c) neither heated nor cooled
(d) first heated and then cooled

Q.21 In the following $P-V$ diagram two adiabatics cut two isothermals at temperatures T_1 and T_2 (fig.). The value of $\frac{V_a}{V_d}$ will be



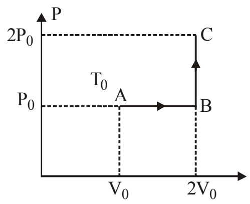
(a) $\frac{V_b}{V_c}$
(b) $\frac{V_c}{V_b}$
(c) $\frac{V_d}{V_a}$
(d) V_bV_c

DIRECTIONS (Q.22 - Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes : **(a)** 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 During the melting of a slab of ice at 273 K and one atmospheric pressure
(1) Positive work is done on the ice-water system by the atmosphere
(2) Positive work is done by ice-water system on the atmosphere
(3) The internal energy of the ice-water system increases
(4) The internal energy of the ice-water system decreases

Q.23 One mole of an ideal monatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC –

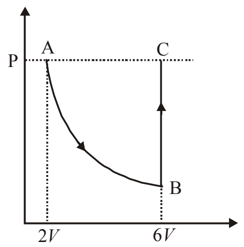


(1) Work done by the gas is RT_0
(2) Change in internal energy of the gas is $\frac{11}{2}RT_0$
(3) Heat absorbed by the gas is $\frac{11}{2}RT_0$
(4) Heat absorbed by the gas is $\frac{13}{2}RT_0$

DIRECTIONS (Q.24-Q.26) : Read the passage given below and answer the questions that follows :

In the figure n mole of a monoatomic ideal gas undergo the process ABC as shown in the P-V diagram. The process AB is isothermal and BC is isochoric. The temperature of the gas at A is T_0. Total heat given to the gas during the process ABC is measured to be Q.

RESPONSE GRID	
	18. ⓐⓑⓒⓓ 19. ⓐⓑⓒⓓ 20. ⓐⓑⓒⓓ 21. ⓐⓑⓒⓓ 22. ⓐⓑⓒⓓ
	23. ⓐⓑⓒⓓ



Q.24 Temperature of the gas at C is equal to

(a) T_0 (b) $3\,T_0$

(c) $6\,T_0$ (d) $2\,T_0$

Q.25 Heat absorbed by the gas in the process BC

(a) $3nRT_0$ (b) nRT_0

(c) $2nRT_0$ (d) $6nRT_0$

Q.26 The average molar heat capacity of the gas in process ABC is

(a) $\dfrac{Q}{nT_0}$ (b) $\dfrac{Q}{2nT_0}$

(c) $\dfrac{Q}{3nT_0}$ (d) $\dfrac{2Q}{nT_0}$

DIRECTIONS (Q. 27-Q.29) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.27 **Statement-1 :** The isothermal curves intersect each other at a certain point.

Statement-2 : The isothermal change takes place slowly, so the isothermal curves have very little slope.

Q.28 **Statement-1 :** In adiabatic compression, the internal energy and temperature of the system get increased.

Statement-2 : The adiabatic compression is a slow process.

Q.29 **Statement-1 :** The specific heat of a gas in an adiabatic process is zero and in an isothermal process is infinite.

Statement-2 : Specific heat of a gas is directly proportional to change of heat in system and inversely proportional to change in temperature.

RESPONSE GRID	**24.** ⓐⓑⓒⓓ **25.** ⓐⓑⓒⓓ **26.** ⓐⓑⓒⓓ **27.** ⓐⓑⓒⓓ **28.** ⓐⓑⓒⓓ **29.** ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 24 - PHYSICS			
Total Questions	29	Total Marks	116
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	44
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

1. **(b)** Differentiate PV = constant *w.r.t.* V

$$\Rightarrow P\Delta V + V\Delta P = 0 \Rightarrow \frac{\Delta P}{P} = \frac{\Delta V}{V}$$

2. **(a)** In isothermal compression, there is always an increase of heat which must flow out the gas.

$$\Delta Q = \Delta U + \Delta W \Rightarrow \Delta Q = \Delta W (\therefore \Delta U = 0)$$

$$\Rightarrow \Delta Q = -1.5\times 10^4 J = \frac{1.5\times 10^4}{4.18} cal = -3.6\times 10^3 \text{ cal}$$

3. **(c)** $\Delta Q = \Delta U + \Delta W$

$$\Rightarrow \Delta U = \Delta Q - \Delta W = 2240 - 168 = 2072\ J.$$

4. **(b)** $W_{iso} = \mu RT \log_e \frac{V_2}{V_1} = 1\times 8.31\times 300 \log_e \frac{20}{10} = 1728J$

5. **(d)** For adiabatic process $\frac{T^\gamma}{P^\gamma - 1}$ = constant

$$\Rightarrow \frac{T_2}{T_1} = \left(\frac{P_1}{P_2}\right)^{\frac{1-\gamma}{\gamma}} \Rightarrow \frac{T_2}{300} = \left(\frac{4}{1}\right)^{\frac{(1-1.4)}{1.4}}$$

$$\Rightarrow T_2 = 300(4)^{\frac{0.4}{1.4}}$$

6. **(d)** PV^γ = constant

$$\Rightarrow \frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^\gamma \Rightarrow P_2 = (8)^{5/3} P_1 = 32P_1$$

7. **(b)** $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$

$$\Rightarrow T_2 = 300\left(\frac{27}{8}\right)^{\frac{5}{3}-1} = 300\left(\frac{27}{8}\right)^{\frac{2}{3}}$$

$$= 300\left\{\left(\frac{27}{8}\right)^{1/3}\right\}^2 = 800\left(\frac{3}{2}\right)^2 = 675K$$

$$\Rightarrow \Delta T = 675 - 300 = 375\ K$$

8. **(b)** In adiabatic change Q = constant $\Rightarrow \Delta Q = 0$

So $\Delta W = -\Delta U (\therefore \Delta Q = \Delta U + \Delta W)$

9. **(d)** $TV^{\gamma-1}$ = constant

$$\Rightarrow T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1} = 927^\circ C$$

10. **(d)** $W = \frac{R(T_i - T_f)}{\gamma - 1} \Rightarrow 6R = \frac{R(T - T_f)}{\left(\frac{5}{3}-1\right)} \Rightarrow T_f = (T-4)K$

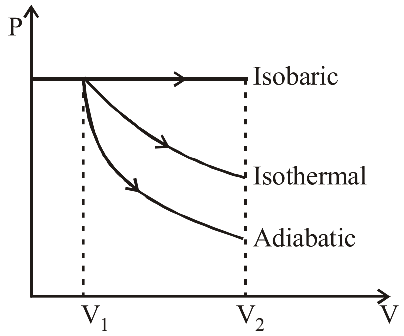
11. **(c)** PV^γ constant : Differentiating both sides

$$P\gamma V^{\gamma-1}dV + V^\gamma dP = 0 \Rightarrow \frac{dP}{P} = -\gamma\frac{dV}{V}$$

12. **(c)** V $\propto$ T at constant pressure

$$\Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2} \Rightarrow V_2 = \frac{V_1T_2}{T_1} = \frac{300\times 280}{300} = 280\,\text{ml}$$

13. **(b)** In thermodynamic process, work done is equal to the area covered by the PV curve with volume axis.
Hence, according to graph shown
$W_{adiabatic} < W_{isothermal} < W_{isobaric}$



14. **(d)** $W = P\Delta V = 2.4\times 10^4 \times 1\times 10^5 = 24J$

15. **(c)** For isobaric process $\frac{V_2}{V_1} = \frac{T_2}{T_1} \Rightarrow V_2 = V\times\frac{274}{273}$

Increase $= \frac{274V}{273} - V = \frac{V}{273}$

16. **(c)** $W = P\Delta V = nR\Delta T = 0.1\times 2\times 300 = 60$ cal

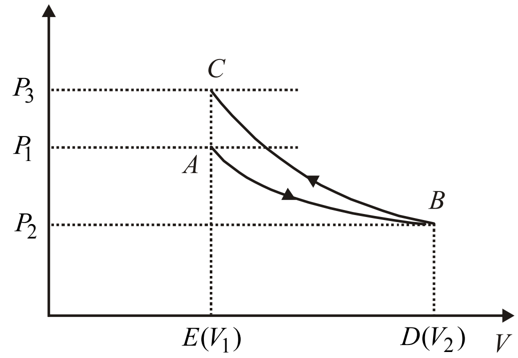
17. **(d)** Fraction of supplied energy which increases the internal energy is given by

$$f = \frac{\Delta U}{(\Delta Q)_P} = \frac{(\Delta Q)_V}{(\Delta Q)_P} = \frac{\mu C_V\Delta T}{\mu C_P\Delta T} = \frac{1}{\gamma}$$

For diatomic gas, $\gamma = \frac{7}{5} \Rightarrow f = \frac{5}{7}$

18. **(a)** In isothermal change, temperature remains constant, Hence $\Delta U = 0$.
Also from $\Delta Q = \Delta U + \Delta W \Rightarrow \Delta Q = \Delta W$

19. (c) From graph it is clear that $P_3 > P_1$.



Since area under adiabatic process (*BCED*) is greater than that of isothermal process (*ABDE*). Therefore net work done

$W = W_i + (-W_A) \therefore W_A > W_i \Rightarrow W < 0$

20. (b) $PV^2 =$ constant represents adiabatic equation. So during the expansion of ideal gas internal energy of gas decreases and temperature falls.

21. (a) For adiabatic process

$$T_1 V_b^{\gamma-1} = \text{Constant}$$

For bc curve

$$T_1 V_b^{\gamma-1} = T_2 V_c^{\gamma-1}$$

or $$\frac{T_2}{T_1} = \left(\frac{V_b}{V_c}\right)^{\gamma-1} \quad \text{....(i)}$$

For ad curve

$$T_1 V_a^{\gamma-1} = T_2 V_d^{\gamma-1}$$

or $$\frac{T_2}{T_1} = \left(\frac{V_a}{V_d}\right)^{\gamma-1} \quad \text{.....(ii)}$$

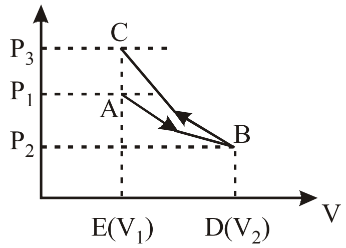
From equation (i) and (ii)

$$\frac{V_b}{V_c} = \frac{V_a}{V_d}$$

22. (d) There is a decrease in volume during melting on an ice slab at 273K. Therefore, negative work is done by ice-water system on the atmosphere or positive work is done on the ice-water system by the atmosphere. Hence option (b) is correct. Secondly heat is absorbed during melting (i.e. ΔQ is positive) and as we have seen, work done by ice-water system is negative (ΔW is negative). Therefore, from first law of thermodynamics $\Delta U = \Delta Q - \Delta W$
Change in internal energy of ice-water system, ΔU will be positive or internal energy will increase.

23. (a) From graph it is clear that $P_3 > P_1$.
Since area under adiabatic process (BCED) is greater than that of isothermal process (ABDE). Therefore net work done

$W = W_i + (-W_A) \because W_A > W_i \Rightarrow W < 0$



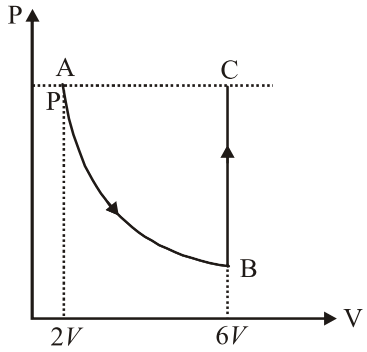
24. (d) Work done = Area of ABC with V-axis
$= P_0(2V_0 - V_0) + 0 = P_0V_0 = nRT_0 = RT_0$
Change in internal energy $= nC_V\Delta T$

$= 1 \times \frac{3}{2}R \times (4T_0 - T_0) = \frac{9}{2}RT_0$

Heat absorbed $= \frac{9}{2}RT_0 + RT_0 = \frac{11}{2}RT_0$

25. (b) AB is an isothermal process then

$P \times 2V = P_B \times 6V \Rightarrow P_B = \frac{P}{3}$



Now BC is an isochoric process then

$\frac{P_B}{T_B} = \frac{P_C}{T_C}$; $\frac{P}{3T_0} = \frac{P}{T_C}$; $T_C = 3T_0$

26. (a) Heat absorbed during BC is given by

$Q = nC_v\Delta T = n \times \frac{3R}{2}(T_C - T_B)$

$= n \times \frac{3R}{2}(2T_0) = 3nRT_0.$

27. (b) Heat capacity is given by

$C = \frac{1}{n}\frac{dQ}{dT}$; $C = \frac{1}{n}\frac{Q}{2T_0}$

28. (c) As isothermal processes are very slow and so the different isothermal curves have different slopes so they cannot intersect each other.

29. (d) Adiabatic compression is a rapid action and both the internal energy and the temperature increases.

30. (a) $c = \frac{Q}{m.\Delta\theta}$; a gas may be heated by putting pressure, so it can have values for 0 to ∞.
C_P and C_V are it's two principle specific heats, out of infinite possible values.
In adiabatic process $C = 0$ and in isothermal process $C = \infty$.